Research Inventy: International Journal of Engineering And Science
Vol.12, Issue 1 (January 2022), PP 17-19
Issn (e): 2278-4721, Issn (p):2319-6483, www.researchinventy.com

Studying the influence of soils under the foundation on the structural system when subjected to seismic loads

Part 1: Methodological content

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Abstract: *Big earthquakes with the intensity of earth-quaking from VII degrees to IX degrees were forecasted to be able to occur in Viet Nam. Therefore, studying to calculate the impacts of earthquakes on building structures in Viet Nam is very necessary. This paper studies the influence of different types of soil on the structural system of high-rise buildings when the building is subjected to earthquakes. After analyzing the model in Etabs software, the authors found that different types of ground for displacement, internal force difference up to 167%. At the same time, the authors also proposed a procedure to calculate the earthquake load-bearing structures using the response spectrum of many types of copper vibrations. It helps design engineers to easily apply structural calculations. To achieve the stated objective of the study. The overall content of this study is organized into four parts. Part 1: Methodological content; Part 2: Research model of a high-rise building in earthquake impact analysis; Part 3: Simulate the impact of earthquakes on a high-rise building; Part 4: proposes a vibration calculation procedure for high-rise buildings.*

Keywords: *Earthquake, high-rise building, response spectrum, displacement, internal force.*

Date of Submission: 01-01-2022 Date of Acceptance: 10-01-2022

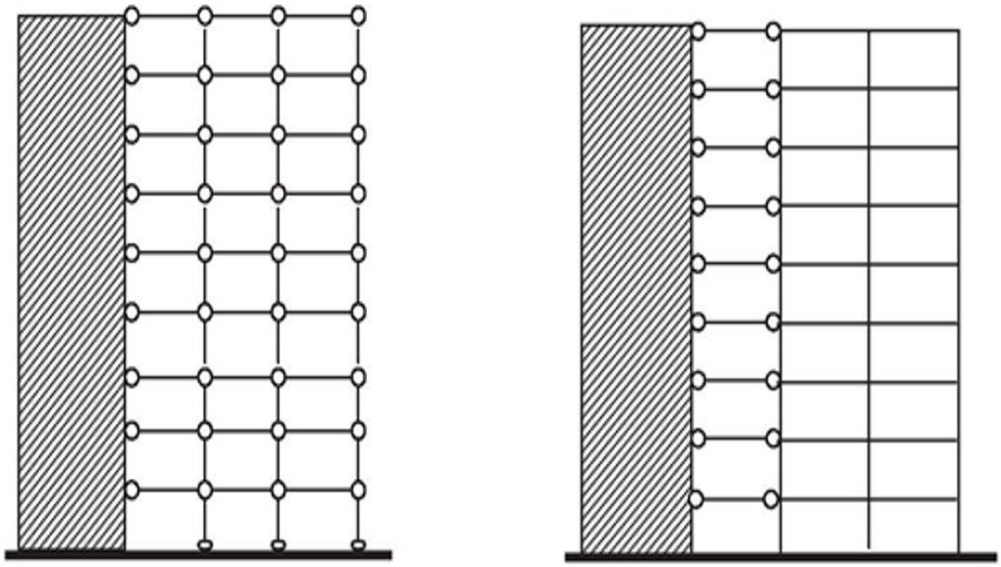
I. INTRODUCTION

Earthquakes are extremely terrible natural disasters because in just a few seconds a large city can completely collapse. Entire areas can be subject to subsidence and sometimes rivers are changed as a result of strong earthquakes. To this day, contemporary scientists and technicians have not been able to accurately predict when and where earthquakes will occur. Therefore, humans do not have active prevention measures for each earthquake. And as an inevitable consequence, when an earthquake occurs, it causes great damage to people and property.However, with earthquake disasters that have occurred in the world and Vietnam, it has been shown that, to minimize the loss of life and property caused by earthquakes, the construction itself must be designed properly. earthquake resistant. Each country must take appropriate measures in this regard.

II. METHODOLOGY

2.1 Design basis of high-rise buildings subjected to earthquake loads

Structures of high-rise buildings need to calculate and design with combinations of vertical loads, horizontal loads (wind: static and dynamic), earthquake loads according to TCVN 2737:1995 "Loads and impacts"; TCVN 9386:2012 Design of earthquake-resistant works; TCXDVN 198 – 1999 High-rise buildings. Structural high-rise buildings need to calculate and check for strength, deformation, stiffness, stability and vibration. Internal force and deformation of high-rise buildings are calculated by the elastic method. For beams, it is possible to adjust the internal force due to plastic deformation. In mixed structures, depending on how the frameworks, it is divided into two diagrams: bracing diagram and frame-brace diagram.



(a) Bracing diagram b) Frame-bracing diagram

Figure 1. **Working diagram of high-rise building**

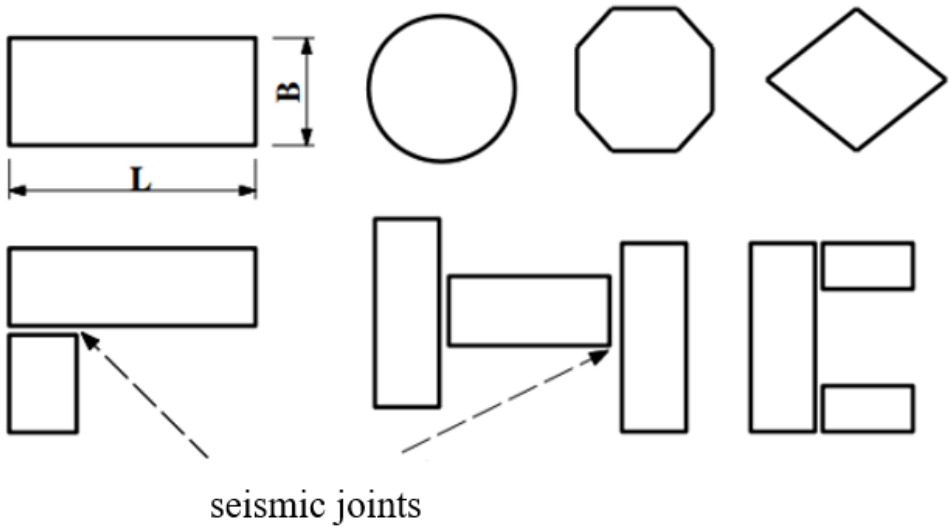


Figure 2. **Types of high-rise dental plan**

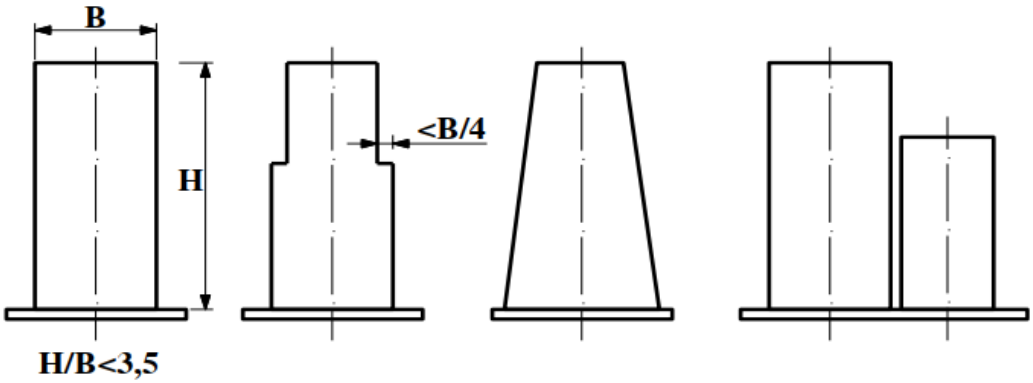


Figure 3. **Shape by height**

2.2 Calculation methods of structures subjected to earthquake loads.

Equivalent static method: The static equivalent calculation method (also known as the equivalent horizontal force method) is the simplest of the methods used to determine the response of structures subjected to earthquakes. This method assumes that the working structure is elastic linearly, while the geometric nonlinearity is considered indirectly. The horizontal loads acting on the building height are considered equivalent to the seismic action and are combined with the vertical loads (gravity forces). This method is often used to design relatively regular works with a basic period of about 1.5 - 2s. For structures with irregular shapes or long periods, dynamic methods should be used. It is more accurate than form analysis or inelastic reaction history analysis.

Nonlinear static calculation method: In this method, the assumed distribution of horizontal inertia forces is based on the assumption that the response of the structure is controlled by a single vibration pattern. The shape of this oscillation remains constant throughout the reaction time. Usually, the chosen fundamental vibrational form is the dominant response form of the dynamic multiple degrees of freedom system. The effects of other types of oscillations are considered to be small and ignored. The nonlinear static calculation method with such a horizontal load distribution is called the conventional incremental calculation method. It is often used to calculate the response of low and medium-height buildings. The method is simple and deterministic with acceptable accuracy. The deformation process of the structural system and its components does not require complicated modeling and elaborate calculations like other dynamic calculations. Therefore, the incremental calculation method is considered an effective and convenient method in dynamic computation.

Vibration analysis method and response spectrum: The response of structures with many degrees of freedom to earthquake action can be calculated by analyzing the structural system into multiple structural systems with one equivalent degree of freedom. Calculate the response of each equivalent system in time and then algebraically add the reactions to get the response of the original structure. If the calculation is only to determine the maximum response quantities, the seismic action will be given as a response spectrum. Calculation results according to the vibration integral method will be the largest response of the structural system. The vibrational integral method, as well as the response spectrum method, has the following disadvantages:

- Depends on the artificial separation of vibrational patterns.
- It is necessary to combine the calculation results in the forms of vibration according to the principle of cooperation, so it is limited to the linear elastic working stage of the material.
-Not applicable to some structural systems that cannot use form analysis techniques.
-Does not give precise instructions on the formation of plastic joints in some members.

III. CONCLUSION

When designing high-rise buildings, it is necessary to consider whether the building is located in an area prone to strong earthquakes to apply the corresponding regulations. A structure without an earthquake-resistant design is called a conventional structure. Special attention should be paid to structural requirements when designing earthquake-resistant structures. According to the analyzed methods, the earthquake calculation model for high-rise buildings will continue to be studied in the following study.

Conflict of interest

There is no conflict to disclose.

ACKNOWLEDGEMENT

This work is supported by Thai Nguyen University of Technology, Vietnam.

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Ha Thanh Tu. "Studying the influence of soils under the foundation on the structural system when subjected to seismic loads Part 1: Methodological content." *International Journal of Engineering and Science*, vol. 12, no. 1, 2022, pp. 17-19.